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ABSTRACT

One hundred eleventh and twelfth grade students were grouped according to their knowledge of and interest in baseball and were then tested for their recall of information presented with varying levels and amounts of background information and analogy. The information was presented in the following ways: (1) analogy embedded in text, (2) analogy given as the topic of an antecedent text, (3) analogy embedded in text in conjunction with an analogous-antecedent text, and (4) information presented on a topic without explicit analogies. The data suggested that attempts to increase background knowledge were more beneficial than a control condition in which no attempt was made, but the overall measures revealed no unique effects related to analogy. Analyses across passages suggested that the more information subjects were given about the unfamiliar topic, the more text reproductions they produced. The group given analogies both in an antecedent text and embedded in the instructional text generated more text reproductions than the other groups. All of the groups given some information in antecedent texts generated more than the control group, which was not given such texts. Student background knowledge seemed to influence recall regardless of treatment condition. (RI)

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CENTER FOR THE STUDY OF READING

Technical Report No. 186

INCREASING BACKGROUND KNOWLEDGE THROUGH ANALOGY: ITS EFFECTS UPON COMPREHENSION AND LEARNING

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Increasing Background Knowledge through Analogy: Its Effects upon Comprehension and Learning

Much of what is expected to be learned in school must be learned through reading and studying text. What can actually be learned from text depends largely on the facility with which learners deal with the way it presents information and on the way it is augmented by teachers. Accordingly, teachers must attend to the way in which text is presented to learners if the thought processes to be elicited are to result in desired learning outcomes. Among other things, teachers must take account of students' existing knowledge as they prepare instructional activities to facilitate the learning of new information. In situations where students may lack the particular background knowledge necessary for reading unfamiliar material, teachers must somehow address the issue of providing it. Teachers have long claimed that an effective way to do this is to provide a bridge between the knowledge the learners do have and unfamiliar information with analogy. They have argued that analogy gives students a familiar interpretative framework for holding together novel information until it is learned. The purpose of the present study was to explore this claim. Specifically, the present study attempted to verify whether attempts to increase background knowledge through analogy would have an impact upon readers' comprehension and learning, and more specifically, whether varying

the presentation of analogy would differentially affect comprehension and learning from unfamiliar prose.

Background to the Study

The purpose of analogy is to explain. Analogy does this by isolating for comparison a set of relations held in common by two sets of complex entities--complex entities being those which comprise two or more interrelated elements. The correspondence between the elements being compared may vary in precision and detail. In some analogies there is not an isomorphic correspondence between the features of the entities under comparison. But those features may be similar enough to enhance understanding without being exactly alike. Or there may be correspondence between some but not all of the features. In stricter kinds of analogies, there is a one-to-one correspondence between the features of the items being compared and the relations presented within each of them. It is the provision of explicit terms common to the entities under comparison which originally gave rise to the notion of analogy in formal thought.

Used as a teaching aid, analogy provides a comparison which can explain something difficult to understand by pointing out its similarities to something easy to understand. Once new material is learned, it in turn may serve as an analogous referent for comparison with still other material to be learned.

In accord with these claims, educational writers advocating the instructional use of analogy maintain that it can increase the speed and efficiency of the learning process. They also claim that analogy facilitates an increased understanding of the old subject material, as well as

enthusiasm for new subject matter. Kahn (1978) and Swick and Miller (1975) assert that in reading instruction, analogies illustrate the necessity for following certain steps to achieve a desired goal and for taking different approaches and attitudes toward different kinds of textual materials. Nelson (1975) posits that analogy is useful in teaching technical vocabulary, forming hypotheses, and discovering concepts. Science educators Weller (1970) and Smith and Wilson (1974) argue that analogies aid in bringing about an initial understanding of scientific concepts and that students are enabled by those analogies to build on the ideas thus acquired. Capps (1979) suggests that the use of analogies which are taken from the language arts can be useful in teaching mathematics. Similarly, Oliphant (1972) advocates the use of analogies from the language arts for explaining certain musical concepts to children.

Educators also appear to be aware of the limitations of analogy and emphasize that care should be taken in its application. If the resemblance between the terms of an analogy is slight, the analogy may be misleading. Because subjects are analogous in many respects, students may have difficulty accepting those respects in which subjects are not analogous. Similarly, students with insufficient background knowledge may think of the analogous model as the concept to be learned rather than an illustration of some other concept.

Philosophers interested in the theoretical and practical aspects of learning and thinking maintain that analogy facilitates comprehension of complex concepts by making them intellectually satisfying. Campbell (1920)

and Black (1962), for example, assert that analogies are important not only in formulating and illustrating concepts but also in extending them to deal with new phenomena and new domains of phenomena. Black, for instance, advocates the use of analogy for comprehending complex theories. He believes that analogies are useful for making properties of a theoretical model better known, arguing that if learners are sufficiently familiar with the realm of knowledge to which the analogy is drawn, they can become versatile in its application and draw inferences from it.

In recent years a number of cognitive psychologists have specified the important role played by background knowledge in comprehension and alluded to the possible benefits of analogy. Within a theoretic framework which derives form the notion of schematism conceived by Kant (1781/1966), developed notably by Bartlett (1932) and Spearman (1923), and recently given prominence by Anderson, Spiro, and Anderson (1978), Neisser (1976), Rumelhart and Ortony (1977), and others, the function and power of analogy for providing a bridge from existing knowledge to new knowledge has been highlighted. Characterizing knowledge as residing within structured thought processes, these writers have hypothesized that learning involves the generalization of knowledge to incorporate new content which is analogously structured. New content is structured to fit within the existing knowledge system, and the knowledge structure is modified through certain mental events to accommodate the new content. Analogy accesses this process by presenting unfamiliar content structured in such a way as to directly engage knowledge which is correspondingly structured (Rumelhart, Note 1).

Despite the practical utility of analogy claimed by educators, and despite the accounting for why it should work by philosophers and psychological theorists, the experimental literature in education and psychology provides little empirical basis for issuing favorable statements about the instructional value of analogy nor, in fact, any attempts to increase background knowledge. Research on the pedagogical application of analogy has been reported by only a few investigators, and the investigations they report have not produced strong evidence to support the instructional use of analogy.

The strongest empirical evidence of the instructional value of analogy has been offered by Ausubel and Fitzgerald (1961), who found that giving readers an advance expository passage on a familiar topic analogous to an unfamiliar topic to be learned from another expository passage resulted in superior learning. Other research has not offered such positive findings. Royer and Cable (1975, 1976) studied the effect of advance presentation of analogous material which was either concrete or abstract, but they did not directly address questions related to the instructional efficacy of analogy. Mayer (1975) found that analogies as well as illustrations and examples appear to elicit relevant knowledge structures for learning, but he drew no conclusions about the effects of analogy per se. Investigations by Dowell (1968) and Drugge (1977) found no significant effects stemming from the instructional use of analogy with high school students. Of the investigations conducted to date, only the Ausubel and Fitzgerald study

has attempted to weigh the effect of prior knowledge of analogous materials. None of the studies has attempted to account for interest related to the analogous materials. Furthermore, all studies have worked from a rather restricted definition of comprehension, and few studies have systematically examined the effects of analogies per se.

Research on analogy also seems especially warranted on theoretical grounds. Of particular interest is the unique role analogy is thought to play in bringing to bear learners' existing knowledge in order to render new knowledge accessible. By studying analogy from a theoretical perspective recently revived in cognitive psychology, schema theory, it may be possible to explore the cognitive processes involved in learning by analogy. Since schema theory suggests that what a person already knows directs the processes by which new information is acquired and used, such a theoretical perspective appears to lend itself well to the study of learning by analogy. In its current stage of development, schema theory is limited to accounting for the processes of comprehension and memory retrieval. As several theorists (Norman, Genter, & Stevens, 1976; Rumelhart & Ortony, 1977; Thorndyke & Yekovich, in press) have emphasized, schema theory needs further development if it is to adequately explain how learning takes place. Rumelhart and Ortony suggested in their paper based upon a composite of schema theoretical notions:

> We have postulated no mechanisms whereby new schemata can grow and old ones evolve. Indeed, this is a central problem for schema theorists and very little work has been done on it. Nevertheless, the nature of schemata suggests a number of plausible mechanisms whereby new schemata can be produced. (Rumelhart & Ortony, 1977, p. 123)

The mechanisms they go on to describe are the processes of schema specialization and schema generalization.[1]

Purpose

The purpose of this study was to examine the effects of attempts to increase background knowledge by having students learn from prose material which was augmented by analogy, and to use this examination to probe theoretical and practical questions of relevance to learning from text. To this end, the study examined (a) the effects of different modes of presenting unfamiliar information--especially through the use of analogy--upon the type of information generated by students of varying levels of relevant background knowledge; as well as (b) the effects of these modes of presentation of information upon the ability of these same students to answer questions developed in accordance with schema-theoretic notions of knowledge generalization and specialization. The different modes of presentation of information were: (a) analogy embedded in text, (b) analogy given as the topic of an antecedent text, (c) analogy embedded in text in conjunction with an analogous-antecedent text, and (d) information presented on a topic without explicit analogies. It was with this purpose in mind that the research question was formulated:

> When a text on an unfamiliar topic is given to students with different levels of knowledge of an analogous topic, how will learning from the text be influenced by (a) analogy embedded in a text, (b) analogous information given as the topic of an antecedent text, (c) analogy embedded in text in conjunction with an analogous antecedent text, and (d) information presented on a topic without explicit analogies?

The topic chosen to be learned from the prose materials was the game of cricket. Where analogies were used, they were drawn to the game of baseball. It was decided that the game of cricket would serve as a satisfactory topic for the instructional texts since American high school students could be assumed to be unfamiliar with cricket (Abramson, 1979). Alternatively, the familiarity of one of its analogs, the game of baseball, could reasonably be assumed.

The research question was addressed by probing a number of subsidiary questions. These subsidiary questions tested analogy's influence on the transfer of learning from prose materials to recalling other, topically related, text and to making appropriate predictions and discriminations on a multiple-choice test.

Questions concerning the recall of topically related text focused on the amount and type of information generated on recall tasks. It was assumed that a person's written recall performance would be affected by the extent of knowledge related to the topic of the text and, further, that inferences could be drawn about the character of a person's cognitive processing on the basis of the amount and generality level of the information recalled. Based upon the notion (Kintsch & van Dijk, 1978; Drum, Note 2) that generality of a person's memory for text reflects extent to which its information has been assimilated, three types of information were identified in subjects' recall protocols: Explicit text reproductions, text-entailed inferences, and text-evoked inferences.

Other questions subsidiary to the research question dealt with analogy's effect on the ability of the subjects to predict appropriate outcomes to open-ended situations related to the topic of the unfamiliar text and to discriminate between instances which were and were not related to the topic of the unfamiliar text. These tasks were developed as a means of approaching an assessment of the learning mechanism of knowledge generalization and knowledge specialization.

Procedures

Subjects

Subjects were eleventh and twelfth graders of average and above-average reading ability from a rural suburban high school in Northern California. Eleventh and twelfth graders were selected from this school for the following reasons: (a) Two previous studies related to the instructional use of analogy (Dowell, 1968; Drugge, 1977) had involved high school students; (b) the student population represented a wide and typical range of social and economic backgrounds. The elimination of students of below-average reading proficiency was prompted by our desire to eliminate subjects who might have difficulty responding to the text. Teacher judgment and standardized reading test results were used as criteria for selecting students.

On the basis of responses given on the surveys of interest and prior knowledge assessment, students from the subject pool were grouped according to three levels of baseball knowledge (high, moderate, low) and three levels of baseball interest (consistently high, mixed, consistently low). Levels

of baseball knowledge were included in the analysis in order to determine the effects of the different experimental treatments relative to level of prior analogous knowledge. Data on levels of interest in sports and baseball were not included in the analysis; rather, they were used to comparably distribute subjects across treatment groups according to levels of interest in sports and baseball.

From these strata, subjects were proportionately assigned to five treatment groups at random. Each treatment group consisted of 21 subjects. The number of subjects in each treatment group actually participating in the experiment ranged from 19 to 21 subjects due to absenteeism on the day of the experiment.

Experimental Materials

A number of materials were developed in order to examine the effects of attempts to increase background knowledge for unfamiliar topics with passages excluding and including analogies. These materials included: a pretest survey of general interest in sports and specific interest in baseball, a pretest to assess background knowledge for baseball, a knowledge-evoking text on the game of baseball, two instructional texts on the game of cricket, two control texts, two passages for recall tasks, and a discrimination-prediction survey for posttest purposes.

General interest in sports was estimated from subjects' responses to a multiple-choice sentence item of the form, "My general feeling about sports is. . . ." Possible responses ranged from "like sports very much" to

"dislike sports very much." The data obtained suggested that all subjects involved in the study had a similar interest in sports and, therefore, general interest in sports would not confound specific interest in baseball.

Levels of specific interest in baseball was ascertained through a rating scale and ranking procedure (Kerlinger, 1973). The first of these measures presented subjects with a list of ten team sports, one of which was baseball, and asked for an indication of interest in each one independent of interest in the others. Students rated interest in each sport along a continuum for "strongly like" to "strongly dislike." The ranking scale included the same list of ten team sports. Students ranked (1-10) the sports from most to least favorite separately for playing and for watching them.

In order to assess subjects' prior knowledge of baseball, a 22-item Likert-type survey was devised. Knowledge of baseball was assessed in order to determine the extent to which it systematically interacted with the treatment variables. The content of the baseball knowledge survey included baseball terms, rules, and situations of play that persons knowledgeable about baseball would know. Salient points of information presented in the expository text on baseball were included as well as points of baseball information to which analogical reference was made in the instructional text on cricket. For example, terms such as ground rule double, batter's box, and leading off were included because reference was made to them in presenting their respective cricket analogs, boundary-four, popping crease, and backing up. Items on the scale required students to select a

response ranging from "definitely true" to "definitely false." To check on the scale's validity, the performance of assumed experts was compared with that of assumed novices. The expert population comprised students who had played interscholastic baseball; the novice population consisted of recently arrived foreign students. The difference between the expert mean (42.8) and the novice (1.7) provided strong support for the validity of the scale. As indicated by a split-half reliability coefficient of .92, the survey reliably discriminated a variety of levels of baseball knowledge.

The knowledge-evoking text was included in the experiment in order to examine the effect of advance presentation of information analogous to the topic of the instructional texts. It described the game of baseball, the topic which served as the familiar analog for explaining the game of cricket in one of the instructional texts. In accordance with Ausubel's (1960) notion that "the most important factor in influencing learning is the quantity, clarity, and organization of the learner's present knowledge" (p. 50), the knowledge-evoking text devoted ample discussion to those subsuming concepts in the baseball text that would be useful for learning the analogous content of the cricket text. Those subsuming concepts provided the organizational framework for presenting the content of the knowledge-evoking text on baseball as well as the instructional texts on cricket. The subsuming concepts included in the knowledge-evoking text in the order given were: an overview of the game and its purpose; the playing field; scoring; the infield as the center of the game's activity; the role of the

pitcher; the role of the batters and base runners; putting out batters and base runners; turns at bat; and completing the game. (Throughout the paper the knowledge-evoking text is referred to as the analogous-antecedent text.)

The instructional texts were based on an article on cricket in Webster's Sports Dictionary (1976). First, an informational text strictly about the game of cricket was written to parallel the knowledge-evoking baseball text. It included an overview of the game, the playing field, scoring, the centerfield, the role of the bowler, the role of batsmen, dismissal of batsmen, turns at bat and completing the game. To create the instructional text, including analogies, selected target structures were rewritten to provide direct feature comparisons with baseball. Portions of these texts appear in Figure 1.

Insert Figure 1 about here.

Two control texts were constructed. The first paralleled the structure of the knowledge-evoking text on baseball; the second, the instructional text on cricket. Neither contained any analogies. The first text was about weather (based upon material from Weather by Lehr, Burnett, Zin, & McNaught, 1965, pp. 10-11, 53-56); the second addressed the topic of film-making (based upon material taken from Young Filmmakers by Larson, 1969).

The two test passages were composites of newspaper articles about cricket taken from the sports section of The Australian (December 1978), a daily newspaper published in Sydney, Australia. Providing two such instances of text for evaluating subjects' comprehension was an attempt

to increase the generalizability of the study's findings by replication. Different cricket match situations were presented within two different idea structures. This permitted identification of subjects who appeared to be more versatile in dealing with information about cricket, that is, who could use the structure of the information to their advantage (Meyer, 1977; Meyer, Brandt, & Bluth, Note 3). An example of one of these texts is presented in Figure 2.

Insert Figure 2 about here.

As a check on the readability of the experimental materials, all texts were reviewed by classroom teachers, all of whom had taught at an eleventh-grade level, and qualified university personnel. They deemed all texts appropriate for the subjects for whom they were intended. As determined by the Fry Readability Graph (1968), all texts were assessed as being at either the sixth- or seventh-grade level.

A discrimination-prediction survey was developed to appraise the extent to which subjects learned the topic of the instructional texts. The survey presented ten cricket match situations and asked subjects to choose the most likely result of that situation from a group of five results for each situation. Twenty-two out of 50 items were not cricket items. In addition to choosing the most likely result to the cricket match situation, subjects were to identify those items that were not within the scope of the game of cricket. As a check on the appropriateness of the test,

educators of Australian and British nationality who reviewed the instrument agreed the scale accurately depicted aspects of cricket.

Data Collection Procedures

Data for the study were collected on two separate occasions. On the first occasion, pre-experimental data were collected on some 150 eleventh- and twelfth-grade students in order to assess their prior knowledge and interests. From these data, students were grouped according to three levels of baseball knowledge (high, moderate, low) and three levels of baseball interest (consistently high, mixed, consistently low) and proportionately assigned to five treatment groups at random. The number of subjects in each treatment group ranged from 19 to 21. On the second occasion, data were collected on 100 of these students during the experiment conducted as an activity in the subjects' regular classes. In the experiment each of the five groups of subjects read a different sequence of passages corresponding to the five treatment conditions and then responded to the test passages as well as the discrimination-prediction survey. In accordance with the sequence of passages read by each group, these treatment groups were labelled: B + C(A), X + C(A), B + C, X + C, and X + X.

Group 1 (B + C(A)) read a baseball passage (B), then an instructional cricket passage with analogies (C(A)).

Group 2 (X + C(A)) read an unrelated passage (X), then an instructional cricket passage with analogies (C(A)).

Group 3 (B + C) read a baseball passage (B), then an instructional cricket passage without analogies (C).

Group 4 (X + C) read an unrelated passage (X), then an instructional cricket passage without analogies (C).

Group 5 (X + X) read two unrelated passages.

All subjects followed the same procedure in reading the passages and responding to the comprehension and learning tasks. Following the introduction to the experiment and some practice exercises, subjects were directed by their teachers to read the first two passages. The directions given by the teacher were to read and study the selection very carefully in order to learn as much as they could about the subject of the passage. They were allowed to mark the passages if they cared to do so and were told to regard the activity as a class assignment. Following the reading of the first and second passages, subjects were directed to read the first test passage and try to remember everything they could. Upon completion, they were instructed to write down everything they could remember. They were given similar directions for the second test passage and were then directed to complete the discrimination prediction survey.

Dependent Measures

With a system of text analysis proposed by Kintsch (1974) and codified by Turner and Green (1977), template text bases of the test passages and protocol text bases of subjects' written recalls were obtained. Protocol text bases were scored by comparing them to their corresponding template text bases according to a procedure suggested by Drum (Note 2). First, a template text base for each test passage was prepared as described above.

Then, referring to the template text base, propositions of each protocol text base were identified as either repeating propositions of the template text base or representing two levels of inferences drawn from the test passages.

Propositions of the protocol text base identified as repeating propositions of the template text base were designated text reproductions. It was not necessary that a protocol proposition be recalled verbatim to be counted as a text reproduction. A protocol proposition was counted as a text reproduction if the content words used to represent its arguments and relations were synonymous with the words so used in the template proposition. A protocol proposition which omitted arguments of a text base proposition was still counted as a text reproduction if the relation and at least one other argument remained intact.

Protocol propositions representing deviations from the text were of two broad categories: propositions which could be directly linked with template propositions and propositions that could not be directly linked with template propositions.

Protocol propositions that could be directly linked to the text base were designated text entailments. Three types of text-entailed propositions were identified during scoring. The first type of text entailment was a proposition which served to summarize certain propositions of the text base. This type of proposition generalized the arguments and relations of two or more specific text base propositions in such a way as to preserve their common meaning at the expense of the specific meanings represented

by each in the text base. The second type of text entailment was a proposition directly related to a single proposition of the text base. It was a text base proposition whose arguments and relations had been generalized to the extent that similarity to the meaning of the text base proposition was not preserved. A third type of text entailment added case-related information to the text base. This type of text entailment was a modifier proposition complementing a predicate proposition of the text base. Since these types of text entailments were not always discrete, the three types were collapsed into a single count of text entailments for purposes of analyzing the data.

Protocol propositions that could not be directly linked to specific propositions of the text base were designated text-evoked propositions. Text-evoked propositions were thematically related to the content of the text base. They were generalizations drawn from the text without any connection to specific propositions of the text base. Drum (Note 2) provides a fourth category of recalls to include implausible, irrelevant, non-text-related propositions. In this study such recalls were not scored. The text-evoked category in this study included only plausible and relevant units of information.

These three types of protocol propositions (text reproductions, text entailments, and text-evoked propositions) were tabulated for each subject's recall for each test passage with interrater agreement of .92 on approximately 10% of the sample. These three scores provided the raw data for the analysis of the recall protocols.

Responses to the discrimination-prediction survey were scored in such a way as to yield three measures. First, an accuracy of prediction score was determined from the number of correct selections of most-likely outcomes to specific cricket match situations. A second measure was derived by counting the number of such outcomes which were within the scope of cricket regardless of their likelihood. This was similar to a context-bound discrimination. A third measure was generated by assessing whether the subjects were able to discriminate cricket from noncricket outcomes without being given a specific cricket match situation. This was similar to a less context-bound discrimination.

Analysis

The data for each dependent variable and each passage were subjected to a number of separate two-way analyses of variance. By examining the data for each passage separately we were able to assess whether the findings would remain stable across different but similar passages; by examining the data for each variable separately, we were able to study any differences which resulted for a measure independently. Specifically, these examinations enabled the following questions to be addressed:

> Was the impact resulting from attempts to increase background knowledge consistent across passages?
>
> Did variations in the impact of attempts to increase background knowledge upon selected variables coincide with schema-theoretic notions of knowledge acquisition and other theoretical notions of reader involvement?

Where significant differences were found, the Scheffé S-method (Scheffé, 1959) was used to examine various comparisons of the groups pairwise and in combination. These comparisons were directed toward answering the following:

> Did any attempts to increase background knowledge influence comprehension and learning?
>
> Did attempts to increase background knowledge using alternative modes of analogy influence comprehension and learning differentially?
>
> Did readers with varying background knowledge of the analogous material respond differentially to these separate comprehension and learning tasks?

Results

The results of the two-way ANOVA's (three levels of background knowledge and five levels of treatment) as well as the results of the Scheffé follow-up tests are reported separetely for each variable and passage.

Total Number of Units Recalled

The means and standard deviations of the total units of information recalled from the first and second test passage are reported in Tables 1 and 2, respectively. The ANOVA for the first test passage revealed no significant differences due to an interaction effect, $F(4,85) = .892$, $p > .05$, nor were there differences across levels of text-analogous

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Insert Tables 1 and 2 about here.

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information, $F(2,85) = .759$, $p > .05$. Significant differences were observed across levels of treatment, $F(4,85) = 5.810$, $p < .001$. Pairwise and combination post hoc comparisons by Scheffé's S-method indicated that the control group significantly differed from each and all other groups. Otherwise, there were no significant differences between or among groups.

For the second test passage, the results of the ANOVA showed no significant differences due to interaction effects, $F(8,85) = .742$, $p > .05$. Nor were there differences across levels of text-analogous knowledge, $F(2,85) = 1.946$, $p > .05$. Significant differences were observed across levels of treatment, $F(4,85) = 4.44$, $p < .01$. Pairwise and combination post hoc comparisons by Scheffé's S-method indicated that the control group significantly differed from each and all other groups. Otherwise, there were no significant differences between or among groups.

Across both passages these data suggested that attempts to increase background knowledge were more beneficial than a control condition in which no attempt was made. Otherwise, reminiscent of the Royer and Cable (1976) study, the overall measure of the present study revealed no unique effects related to analogy. Just as the Royer and Cable study was limited by its overall recall score, so this particular measure in the present study provided little or no differential information about subjects' recalls. The total recall score reflected recall performance in a general way. As the sum of all the information given in a recall, it did not indicate the kind of information generated.

Number of Text Reproductions

The means and standard deviations for the number of text reproductions contained in the recalls of subjects are reported in Tables 3 and 4 for passages 1 and 2, respectively. Analysis of the data of the first recall task revealed no significant interaction effect for the number of text reproductions, $F(8,85) = 1.55$, $p > .05$. Nor were significant differences revealed across levels of text-analogous knowledge, $F(2,85) = 1.07$, $p > .05$. However, significant differences were noted across treatment groups' recalls of the first test passages, $F(4,85) = 2.77$, $p < .05$. Scheffé post hoc pairwise comparisons indicated that, on the first test passage, the group given analogy embedded in the instructional text in conjunction with the analogous antecedent text (B + C(A)) produced significantly more text-reproduced information than the group given analogy embedded in the instructional text in conjunction with the unrelated antecedent text (X + C(A)). Otherwise, there were no significant differences on the first test passage between groups given instructional texts. On the first passage, the control group differed significantly from groups given instructional texts in number of text reproductions generated.

Insert Table 3 about here.

Analysis of the data of the second recall task yielded similar results. There was no significant interaction effect for the number of text reproductions given by subjects, $F(8,85) = 1.118$, $p > .05$. In other words, no method of presenting the texts on cricket in this investigation seemed to

hold any better effect than any of the others for promoting the recall of topically related passages by subjects with particular levels of knowledge about baseball. Nor were significant differences revealed across levels of text-analogous knowledge, $F(2,85) = .150$, $p > .05$. However, significant differences were noted across treatment groups' recalls of the second test passage, $F(4,85) = 3.492$, $p < .05$. Scheffé post hoc pairwise comparisons indicated that, on both test passages, the group given analogy embedded in the instructional text in conjunction with the analogous antecedent text (B + C(A)) produced significantly more text-reproduced information than the group given only analogy embedded in the instructional text (X + C(A)). Otherwise, there were no significant differences on the second test passage between groups given instructional texts. Scheffé post hoc pairwise, as well as combined, comparisons showed that on the second test passage, the control group produced significantly less text reproduced information than each and all groups given instructional texts.

Insert Table 4 about here.

In general, these analyses across passages suggest that the more information subjects were given about the unfamiliar topic the more text reproduction they produced. The group given analogy both in the antecedent text and embedded in the instructional text (B + C(A)) generated more text reproductions than the other groups. Furthermore, all of the groups given some information in antecedent texts generated more than the control group, which was not given such texts.

Number of Text Entailments

The means and standard deviations derived for the total number of text entailments in the students' written recalls for test passages 1 and 2 are reported in Tables 5 and 6, respectively. The analysis for the first recall task showed no significant interaction between levels of text-analogous knowledge and treatment, $F(8,85) = .864$, $p > .05$. Nor were there significant differences across levels of text-analogous knowledge, $F(2,85) = 2.697$, $p > .05$. Significant differences in the mean number of text entailments were observed across the treatment groups, $F(4,85) = 7.431$, $p < .001$. Scheffé post hoc comparisons indicated that the control group produced significantly less text-entailed information than the groups given the instructional texts. The groups given antecedent instructional texts dealing with the analogous topic (B + C(A), B + C combined) produced significantly more text-entailed information than did groups which were given the non analogous antecedent texts (X + C(A), X + C combined). Among the groups given instructional texts with analogy, the group given analogies embedded in the instructional text with the unrelated antecedent text (X + C(A)) produced significantly less entailed information than the other two groups given texts with analogy (B + C(A), B + C).

Insert Table 5 about here.

The analysis of variance for the second recall task showed no significant interactions between levels of text-analogous knowledge and levels of treatment, $F(8,85) = 1.127$, $p > .05$. No significant differences were

found across levels of text-analogous knowledge, $F(2,85) = 1.008$, $p > .05$. And no significant differences were found across treatment groups, $F(4,85) = 2.264$, $p > .05$.

Insert Table 6 about here.

The results of these analyses were consistent with the research assumption that reader interaction with text results in modified recollections of the text. Antecedent instructional texts dealing with the analogous topic apparently promoted reader-text engagement on the first test passage at a level which resulted in a greater number of text entailments than would have been produced otherwise, assuming that the recall of the control group and the group not given analogy represent the frequency of text-entailed information that would have otherwise been produced.

That the treatment group differences on the first recall task did not hold for the second recall task may be explained by the data as possibly resulting from a combination of two factors. The first contributing factor may have been that the control group learned enough from the first passage to generalize the propositions of the second test passage. The control group's mean text entailment recall improved by 45% on the second test passage. A second possible explanation is that the second recall task appears to have neutralized the beneficial effect of the analogy. The analogy groups' mean recall diminished, altogether by about 30%, while the mean recall of the instructional group without analogy remained about the same.

Number of Text-Evoked Units

The means and standard deviations derived for the total number of text-evoked units in the students' written recalls for test passages 1 and 2 are reported in Tables 7 and 8, respectively. The results of this ANOVA did not reveal a significant interaction effect in the number of text-evoked units of information given by subjects across levels of text-analogous knowledge across treatment groups, $F(8,85) = 1.317$, $p > .05$. Nor were there significant differences across levels of text-analogous knowledge on the first test passage, $F(2,85) = .889$, $p > .05$. Significant differences were found in the number of text-evoked units of information given by subjects across treatment groups, $F(4,85) = 3.26$, $p < .05$.

Insert Table 7 about here.

Scheffé post hoc combination comparisons showed that the groups given analogy (B + C(A), X + C(A), B + C combined) produced significantly more text-evoked information than the other groups (X + C, X + X combined), and that the group given analogy embedded in the instructional text in conjunction with the unrelated antecedent text (X + C(A)) produced significantly more text-evoked information than the other groups. In terms of the latter, pairwise comparisons showed that the group given analogies embedded in the instructional text with the unrelated antecedent text (X + C(A)) produced significantly more text-evoked information than the group given no analogy and the group given analogy both embedded in the instructional text and with the antecedent text.

For the second passage, the number of text-evoked units of information given by subjects across levels of knowledge across treatment groups were not significantly different, $F(8,85) = 1.861$, $p > .05$. Nor were significant differences found across treatment groups, $F(4,85) = 1.912$, $p > .05$. Significant differences were found in the number of text-evoked units of information given by subjects across levels of text-analogous knowledge, $F(2,85) = 3.673$, $p < .05$.

Insert Table 8 about here.

Pairwise as well as combination post hoc comparisons by the Scheffé method showed that subjects with a high level of text-analogous knowledge produced significantly more text-evoked information on the second recall task than did subjects at either of the other two levels of text-analogous knowledge. Subjects with moderate and low levels of text-analogous knowledge did not significantly differ in the number of units of text-evoked information they produced. This finding suggested that students' background knowledge had an influence on the extent to which their recall included text-evoked recall units, or was reader-based, regardless of the treatment condition received.

Responses to Prediction Task

The means and standard deviations based upon the subjects' responses to the prediction task (selection of appropriate outcomes to cricket-match situations) are presented in Table 9. Analyses of the subjects' performance

on this task revealed that the interaction effect was not significant. There were no significant differences across levels of text-analogous knowledge across treatment groups, $F(8,85) = 2.016$, $p > .05$. Nor were there differences across levels of text-analogous knowledge, $F(2,85) = 2.117$, $p > .05$. Significant differences across treatment groups were indicated, $F(4,85) = 43.185$, $p < .001$. In pairwise as well as combination post hoc comparisons, the control group made significantly fewer correct predictions than did the other treatment groups. There were no significant differences across treatment groups given instructional texts. In other words, by itself this measure indicated that subjects given background information on the game of cricket were better able to predict appropriate outcomes to open-ended cricket match situations; no differences in the ability to generalize that background information could be attributed to different modes of analogy.

Insert Table 9 about here.

Responses to Discrimination Tasks

The means and standard deviations derived for the discrimination tasks are presented in Tables 10 and 11. Analyses of subjects' performance on the discrimination tasks suggested that there were differences on the first measure (the number of irrelevant predictions when students were asked to specify the most-likely outcome) but not on the second (the number of topically inconsistent items of information specified by students).

On neither measure was there a significant interaction effect, $F(8,85) = 1.505$, $p > .05$, $F(8,85) = .319$, $p > .05$; nor were there significant differences across levels of text-analogous knowledge, $F(2,85) = 2.398$, $p > .05$, $F(2,85) = .649$, $p > .05$. There were no significant differences across treatment groups in number of items identified as not belonging within the domain of the topic to be learned, $F(4,85) = 1.547$, $p < .05$. Significant differences were noted, however, across treatment groups in the selection of items related to the analog rather than to the topic itself in the prediction task, $F(4,85) = 7.090$, $p < .001$.

Insert Tables 10 and 11 about here.

Pairwise as well as combination post hoc comparisons revealed that the group given analogies in the instructional text in conjunction with the analogous antecedent text (B + C(A)) selected significantly fewer items related to the analog than the other groups given instructional texts or the control group. In general, the data showed that subjects given some background information on the game of cricket were better able to discriminate between instances which were and which were not related to the game of cricket if discriminations were made in direct connection with a particular cricket match situation. Knowledge of cricket, however, was not so firmly established and finely differentiated that discriminations could reliably be made without reference to a particular cricket match situation. That is, there was a significant difference in the ability of subjects to discriminate when given a cricket match situation; outside the context of a specific cricket match

situation to which instances could be tied, subjects did not significantly vary in making discriminations.

Discussion

At the outset, it was suggested that the central purpose of the present study was to investigate whether attempts to increase background knowledge, especially through analogy, would have an impact upon a reader's comprehension and learning. Of particular interest were answers to the following questions:

Did any attempt to increase background knowledge influence comprehension and learning?

Did attempts to increase background knowledge using alternative modes of analogy influence comprehension and learning differentially?

Did readers with varying amounts of background knowledge of the analogous material respond differentially to the various comprehension and learning tasks?

Did the impact resulting from attempts to increase background knowledge remain stable across the passages which were recalled?

Did the comprehension and learning resulting from attempts to increase background knowledge coincide with schema-theoretic notions of comprehension and knowledge acquisition as well as other theoretic notions of reader involvement?

For purposes of discussion, the results of the study are related to each of these questions.

Did any attempt to increase background knowledge influence comprehension and learning? Across almost all analyses the data suggested that the more information subjects were given about the unfamiliar topic, the better was

their performance on the written recall task as well as prediction-discrimination tasks. On the written recall tasks, all of the subjects given instructional texts (treatment conditions B + C(A), X + C(A), B + C, X + C) produced significantly more information at all levels of generality than the control subjects (X + X), who were not given such texts. For the first recall task, the findings with respect to the total number of units, the number of text reproductions, text entailments and text evocations consistently favored those subjects given information for the unfamiliar topic; for the second recall task, this trend was consistent for the total number of units recalled and for text reproductions alone. In terms of performance on the prediction and discrimination tasks, subjects given background information were better able to make accurate predictions and to discriminate information consistent with a specific instance of the unfamiliar topic. In terms of the latter, subjects given information on the unfamiliar topic were better than control subjects in being able to make discriminations if the information was connected to a specific instance of the topic. In light of the dearth of support from similar empirical endeavors, the present results should be viewed as being far from trivial. Unlike most other studies in which attempts have been made to increase background knowledge, the present data provide strong support for the efficacy of the treatment conditions over the control condition. In this regard, the data provide some clarification of the nature of the effects of increasing background knowledge upon comprehension and learning.

Did attempts to increase background knowledge using alternative modes of analogy influence comprehension and learning differentially? Pairwise and combination comparisons indicated that differences observed in the subjects' performance on three of the recall measures as well as on one of the prediction-discrimination tasks varied according to the method by which analogy was presented in text. Differences in the number of text reproductions produced in response to the first recall task favored the use of analogy embedded in the instructional text together with the analogical antecedent text (B + C(A)); differences in the number of text entailments favored the use of the analogical antecedent text (B + C(A), B + C); differences in the number of text evocations favored the use of the analogies either embedded or as an antecedent text [(X + C(A)) + (B + C) + (B + C(A))] over the presentation of information without analogical qualities. On the prediction and discrimination tasks, subjects given analogy were not distinguished from subjects given texts without analogy in predicting appropriate outcomes to the given cricket match situations. Nor were they distinguished from the non-analogy subjects in their ability to identify irrelevant information independently of a particular context. However, the group given analogy both in the advance text and embedded in the instructional text (B + C(A)) were better able to discriminate between cricket and non-cricket information if the discriminations were made within the context of a particular cricket match situation. In general, then, the use of these alternative modes of presenting information did have a

differential impact which tended to favor the use of analogy over the presentation of information without analogical qualities. This was especially the case with respect to the extent to which readers' recalls were integrated. Specifically, alternative modes of presenting analogy prompted recalls which were more reader-based--that is, more text evocations were produced--and they prompted learning which was reflected in certain types of discrimination and not others.

Did readers with varying amounts of background knowledge respond differentially to the various comprehension and learning tasks? The data revealed scant, if any, association between treatment effects and subjects' level or prior background knowledge of the analogous material. The only indication of a differential response related to the background knowledge was given by high knowledge subjects on the second recall task, where they produced significantly more text evocations than other control subjects. That result by itself can at best only hint that those subjects had been cued by the first recall task to turn to their store of relevant analogous knowledge for application in reading and recalling the second passage.

The failure of the present study to find other differences across levels of analogous background knowledge may well have resulted from design limitations. On the pre-experimental baseball knowledge survey, very few of the subjects scored as low as the highest-scoring baseball-naive person who completed the survey in the validation procedures.

Within the range obtained, an attempt was made to segment subjects into three levels of knowledge--high, moderate, and low. It seems doubtful, however, that the three groups represented discrete levels of knowledge, since there was a limited interval separating the scores of the low and moderate groups and the moderate and high groups. That several of the differences across levels of text-analogous knowledge in the present study approached significance suggests that if there had been more separation between levels of knowledge, significant differences might have been obtained.

Did the impact resulting from attempts to increase background knowledge remain stable across the passages which were recalled? Significant differences between treatment groups persisted across both recall tasks on only one measure of recall, that of text reproduction. Differences between the groups on text-entailed and text-evoked recall measures on the first written recall task faded on the second recall task. Perhaps the subjects learned enough from the first recall task itself to neutralize treatment effects on the second recall task. Perhaps subjects were cued during the first task to independently resort to their own store of analogous knowledge for use in the second task. Perhaps subjects learned to cope with the novel demands of the recall task during their first attempt. Without controlling time on task we had no way to ensure that on-line processing remained constant. A hypothesis which was not pursued was the effects of attempts to increase background knowledge upon the behavior of readers <u>during</u> comprehending. Any of these possibilities point to the limitations not only of the present study, but comprehension and learning research in general; they emphasize

the need to address research on learning from text with a great deal of suppleness. Procedures for delineating individual differences need to be carefully operationalized; methods of measuring on-line processing as well as other aspects of comprehension and learning need to be included.

Did the comprehension and learning which resulted from attempts to increase background knowledge coincide with schema-theoretic notions of comprehension and knowledge acquisition as well as other theoretic notions of reader involvement? The data collected in the present study were examined from theoretical perspectives that explain the amount of information recalled (Kintsch, Kozminsky, Sterky, McKoon, & Keenan, 1975; Marshall, 1976) as well as the inverse relationship between explicit recall and generalized recall (Kintsch & van Dijk, 1978; Spiro, 1977). According to these perspectives, the more the involvement of the reader, the more information recalled and the greater the integration of text information with reader knowledge. The data provided substantial support for these perspectives; further, they emphasize one reason for involvement or non-involvement with text: degree of knowledge about the topic of the text. Indeed, it would appear that subjects given texts with analogy recalled more total units of recall and interacted with text to a greater extent than subjects who were given texts without analogy and that they gained a better sense of the texts' meaning. Further, the advance presentation of analogy in the form of an antecedent text seemed to provide for retention of explicitly stated information, but analogy embedded in text seemed to provide for more generalized treatment of the text. Where two modes of presenting analogy were combined

(B + C(A)), significantly more text-based information was generated on both passages than by the group given analogy by text embedding only (X + C(A)), but significantly less reader-based information than generated by the latter group at least on the first passage. Although the measures devised to address schema specialization and generalization were neither discrete nor comparable, the performance of the subjects on the prediction and discrimination tasks suggested that knowledge gained from the instructional texts had begun to form some other transfer values of relevance to these notions. Subjects given background information related to the tasks were better able to make predictions for the open-ended text-related situations. Also, they were better able to discriminate information consistent with the topic if that information was connected to a specific instance of the topic. Subjects given background information related to the tasks were not more able than control group subjects to make discriminations between topic-consistent and topic-inconsistent information when that information was not presented in some particular context. Subjects given analogy both in the advance text and embedded in the instructional text appeared to make the best context-related discriminations between instances and non-instances of the topic. In terms of the notions of schema specialization and generalization, the data from the present study did suggest knowledge appeared first to generalize to specific instances on the novel content and then to specialize within the context of those specific instances. The data indicated that independent generalization of knowledge, that is, generalization within specific applicative contexts, did not appear to be achieved by the subjects in this investigation.

Implications for Research

What implications can be drawn for further research which examines attempts to increase background knowledge? The present study raised more questions about increasing background knowledge than it answered. For example, the present study investigated only four ways of presenting unfamiliar information. The differential effects of other modes of presenting information need to be investigated in order to determine their instructional efficacy for meeting specific instructional goals. With respect to presenting information through analogy, examples of other modes which might be investigated include analogical annotation, analogical questions, analogous and vicarious experiences, self-generated and selected analogies, concurrent reading on analogous topics, and analogical study guides. Comparison might also be made with other aids to textual instruction such as illustrations, as well as concrete and abstract examples. Increasing background knowledge has been studied in connection with some of these other aids to instruction, but conclusive findings as to their effectiveness are lacking. What is significant about the present study is that it confirms the worth of such endeavors and suggests some guidelines for future research studies.

What guidelines for conducting similar research are prompted? In terms of design considerations, the present study raised several important issues. Differences were noted across levels of treatment and prior analogous knowledge that could not have been detected by the overall measure of recall typically used in previous studies. Analysis of text recalls by levels of generality appeared to afford the detection of such differences in recalled information not obtainable by an overall measure of text recall. If suggested

that differential information on the responses of readers to question types may help researchers specify how and what other learning takes place. Alternatively, the pre-study failed to adequately address several important variables. First, the extent to which the treatment conditions as employed in the present study focused attention on the more important information of the text was not ascertained from the recall data. Recalled information by level in the idea structure of the passages could not be clearly interpreted since text reproductions could not be analyzed together with text entailments at each level. For example, text entailment that summarized propositions variously located in a passage's idea structure could not be assigned a single level in the ideational structure.

Second, subjects responded to experimental texts immediately following their presentation; neither delayed posttest nor on-line processing measures were used. Furthermore, given the findings that there were differences in text-based and reader-based information across the recall tasks, the issue of the stability of background differences might have been pursued further.

Third, readers' interest in the analogous material was considered in this study only to the extent of controlling its potential influence on the dependent measures. The interactive effects of analogy with subjects' interest in the analog were not investigated. From a practical standpoint such investigation appears to be warranted.

Fourth, subjects involved in the present study did not represent extreme levels of background knowledge and no attempt was made to assess

individual differences in background knowledge after the introduction of the instructional texts. Given this limitation and the fact that many of the differences in measures approached significance, it might have been worthwhile to have sought subjects who represented a greater separation in knowledge about baseball.

Concluding Remarks

In general, the findings of the present study should be considered encouraging. They support assertions by educators, philosophers, and psychologists that attempts to increase background knowledge facilitate learning unfamiliar material. The present attempts using alternative modes of analogy did promote learning from text. That the different ways in which attempts were made to increase knowledge differentially influenced learning indicates a need to move from broad notions about the instructional utility of strategies directed toward increasing background knowledge toward more refined and differential concepts about their application. Of theoretical and practical relevance, then, the use of analogies and other methods for increasing background knowledge appear to offer promise as a means of examining issues of relevance for dealing with unfamiliar information.

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Footnotes

[1]Schema specialization, as Rumelhart and Ortony describe it, means constraining schema variables so as to reduce the possible values that may be assigned to yield a representation of information; reducing assignable values specializes the schema so that it yields more highly differentiated representations. Schema generalization, conversely, means extending the possible values that schemata may assign to yield a representation of information; relaxing the constraints on schematic variables results in a representation which is more abstract or generalized.

Table 1

Summary of Means and Standard Deviations of Total Units of Information Recalled:

First Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	15.43	8.07	(9)	17.44	6.69	(6)	12.33	7.28	(6)	15.50	10.80
2 (X + C(A))	(20)	12.85	6.01	(8)	14.38	5.78	(6)	15.00	5.93	(6)	8.67	5.01
3 (B + C)	(20)	15.25	3.88	(10)	15.90	3.14	(4)	14.25	1.71	(6)	14.83	5.98
4 (X + C)	(19)	14.11	4.58	(8)	13.13	6.10	(6)	15.33	3.14	(6)	14.20	3.56
5 (X + X)	(20)	8.10	3.95	(9)	8.11	3.10	(6)	8.33	3.01	(5)	7.80	6.57
					13.84	5.87		12.96	5.24		12.29	7.23

Note. Overall Mean = 13.16; Standard Deviation = 6.09; n = 100.

Table 2

Summary of Means and Standard Deviations of Total Units of Information Recalled: Second Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	22.81	7.24	(9)	24.44	6.09	(6)	20.50	7.82	(6)	22.67	8.82
2 (X + C(A))	(20)	20.85	7.95	(8)	22.38	7.96	(6)	21.50	7.18	(6)	18.17	9.23
3 (B + C)	(20)	21.50	5.41	(10)	22.30	4.90	(4)	20.50	8.81	(6)	20.83	4.36
4 (X + C)	(19)	22.26	6.38	(8)	24.25	3.28	(6)	19.17	8.61	(5)	22.80	6.98
5 (X + X)	(20)	14.95	6.53	(9)	16.44	7.00	(6)	17.17	5.04	(5)	9.60	4.98
					21.91	6.47		19.71	7.10		19.00	8.24

Note. Overall Mean = 20.48; Standard Deviation = 7.22; n = 100.

Table 3

Summary of Means and Standard Deviations of Number of Text Reproductions: First Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	9.76	6.03	(9)	11.56	4.69	(6)	6.67	4.92	(6)	10.17	8.28
2 (X + C(A))	(20)	6.85	4.45	(8)	6.75	3.15	(6)	9.67	5.68	(6)	4.17	3.31
3 (B + C)	(20)	8.40	3.50	(10)	7.60	3.06	(4)	8.00	1.63	(6)	10.00	4.86
4 (X + C)	(19)	8.84	3.39	(8)	7.63	4.44	(6)	10.67	1.63	(5)	8.60	2.41
5 (X + X)	(20)	5.80	3.74	(9)	5.56	2.92	(6)	6.00	2.61	(5)	6.00	6.36
					7.84	4.09		8.21	3.99		7.82	5.65

Note. Overall Mean = 7.94; Standard Deviation = 4.51; n = 100.

Table 4

Summary of Means and Standard Deviations of Number of Text Reproductions:

Second Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	17.43	6.10	(9)	18.67	5.32	(6)	15.67	6.68	(6)	17.33	7.26
2 (X + C(A))	(20)	14.30	7.13	(8)	16.50	7.52	(6)	14.50	6.95	(6)	11.17	6.79
3 (B + C)	(20)	15.65	5.34	(10)	14.10	4.48	(4)	18.00	9.02	(6)	16.67	3.61
4 (X + C)	(20)	16.05	5.83	(8)	15.13	4.97	(6)	14.50	6.66	(5)	19.40	5.90
5 (X + X)	(20)	10.75	5.96	(9)	11.56	6.86	(6)	12.50	5.47	(5)	7.20	3.96
					15.14	6.11		14.82	6.55		14.43	6.91

Note. Overall Mean = 14.85; Standard Deviation = 6.41; n = 100.

Table 5

Summary of Means and Standard Deviations of Number of Text Entailments:

First Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	4.19	2.46	(9)	4.67	2.45	(6)	3.50	1.52	(6)	4.17	3.37
2 (X + C(A))	(20)	3.35	2.23	(8)	3.75	2.71	(6)	4.00	1.90	(6)	2.17	1.60
3 (B + C)	(20)	4.50	1.91	(10)	5.20	1.48	(4)	4.75	0.96	(6)	2.17	2.48
4 (X + C)	(19)	3.89	1.91	(8)	4.25	2.49	(6)	2.83	0.75	(5)	4.60	1.52
5 (X + X)	(20)	1.45	1.32	(9)	2.00	1.50	(6)	1.67	1.17	(5)	0.80	0.84
					4.00	2.34		3.14	1.74		3.00	2.45

Note. Overall Mean = 3.48; Standard Deviation = 2.25; n = 100.

Table 6

Summary of Means and Standard Deviations of Number of Text Entailments:

Second Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	3.43	2.62	(9)	4.33	2.60	(6)	3.00	2.83	(6)	2.50	2.43
2 (X + C(A))	(20)	3.15	3.13	(8)	2.63	2.20	(6)	2.67	2.42	(6)	4.33	4.72
3 (B + C)	(20)	2.05	1.93	(10)	2.40	2.32	(4)	1.50	1.29	(5)	1.83	1.72
4 (X + C)	(19)	3.79	2.39	(8)	5.00	2.00	(6)	3.17	2.71	(5)	2.60	2.07
5 (X + X)	(20)	2.10	1.55	(9)	2.00	1.22	(6)	3.17	1.72	(5)	1.00	1.22
					3.23	2.34		2.79	2.23		2.50	2.81

Note. Overall Mean = 2.90; Standard Deviation = 2.45; n = 100.

Table 7

Summary of Means and Standard Deviations of Number of Text Evoked Propositions: First Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	1.48	1.72	(9)	1.22	0.97	(6)	2.17	2.93	(6)	1.17	0.98
2 (X + C(A))	(20)	2.65	2.23	(8)	3.88	1.81	(6)	1.33	1.97	(6)	2.33	2.42
3 (B + C)	(20)	2.35	2.35	(10)	3.10	2.81	(4)	1.50	1.29	(6)	1.67	1.86
4 (X + C)	(19)	1.37	1.74	(8)	1.25	1.28	(6)	1.83	2.79	(5)	1.00	0.71
5 (X + X)	(20)	0.85	0.99	(9)	0.56	0.53	(6)	1.17	1.60	(5)	1.00	0.71
					2.00	2.07		1.61	2.13		1.46	1.52

Note. Overall Mean = 1.74; Standard Deviation = 1.95; n = 100.

Table 8

Summary of Means and Standard Deviations of Number of Text Evoked Propositions: Second Test Passage

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	1.95	1.83	(9)	1.44	1.67	(6)	1.83	2.14	(6)	2.83	1.72
2 (X + C(A))	(20)	3.40	2.87	(8)	3.25	3.20	(6)	4.33	3.08	(6)	2.67	2.42
3 (B + C)	(20)	3.80	3.75	(10)	5.80	4.37	(4)	1.00	0.00	(6)	2.33	1.51
4 (X + C)	(19)	2.42	2.78	(8)	4.13	3.32	(6)	1.50	1.64	(5)	0.80	1.30
5 (X + X)	(20)	2.10	2.31	(9)	2.89	3.05	(6)	1.50	1.22	(5)	1.46	1.52
					3.55	3.46		2.11	2.20		2.07	1.80

Note. Overall Mean = 2.73; Standard Deviation = 2.82; n = 100.

Table 9

Summary of Means and Standard Deviations of Number of Correct Predictions

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	5.81	2.36	(9)	7.00	2.12	(6)	4.33	1.86	(6)	5.50	2.51
2 (X + C(A))	(20)	6.10	2.00	(8)	6.38	2.00	(6)	7.33	1.37	(6)	4.50	1.64
3 (B + C)	(20)	6.25	1.52	(10)	6.30	1.64	(4)	6.75	1.89	(6)	5.83	1.17
4 (X + C)	(19)	6.05	1.18	(8)	5.88	0.64	(6)	5.83	1.60	(5)	6.60	1.34
5 (X + X)	(20)	2.80	1.58	(9)	3.22	1.92	(6)	2.50	1.52	(5)	2.40	0.89
					5.81	2.36		6.10	2.00		6.25	1.52

Note. Overall Mean = 5.40; Standard Deviation = 2.19; n = 100.

Table 10

Summary of Means and Standard Deviations of Number of Irrelevant Predictions

(Context-bound Discrimination)

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	0.76	1.04	(9)	0.44	0.73	(6)	0.83	0.75	(6)	1.17	1.60
2 (X + C(A))	(20)	1.35	1.57	(8)	1.13	1.25	(6)	0.67	0.82	(6)	2.33	2.16
3 (B + C)	(20)	1.85	3.05	(10)	1.20	1.03	(4)	4.50	6.35	(6)	1.17	1.47
4 (X + C)	(19)	1.21	1.08	(8)	0.75	1.04	(6)	1.50	1.05	(5)	1.60	1.14
5 (X + X)	(20)	3.45	1.67	(9)	3.00	1.87	(6)	4.00	1.79	(5)	3.60	1.14
					2.91	1.46		2.79	1.37		2.96	1.40

Note. Overall Mean = 2.89; Standard Deviation = 1.41; n = 100.

Table 11

Summary of Means and Standard Deviations of Number of Correctly Identified Topically Inconsistent Items of Information (Context-Free Discrimination)

Treatment Group	Total			Level of Text-Analogous Knowledge								
				1			2			3		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
1 (B + C(A))	(21)	13.76	4.66	(9)	13.11	5.16	(6)	13.50	4.23	(6)	15.00	4.86
2 (X + C(A))	(20)	10.80	5.85	(8)	10.75	5.20	(6)	10.83	6.49	(6)	10.83	7.08
3 (B + C)	(20)	14.65	4.63	(10)	13.40	5.06	(4)	15.50	3.51	(6)	16.17	4.62
4 (X + C)	(19)	12.79	3.54	(8)	13.00	2.62	(6)	10.83	4.96	(5)	14.80	1.64
5 (X + X)	(20)	11.80	4.43	(9)	12.00	3.94	(6)	11.83	5.74	(5)	11.40	4.56
					12.50	4.43		12.29	5.10		13.63	5.08

Note. Overall Mean = 12.77; Standard Deviation = 4.80; n = 100.

Figure Captions

Figure 1. Portions of instructional texts with and without embedded analogies. (It should be noted that underlining was not used in the text during the experiment.)

Figure 2. Test Passage One (based on "Wood's 100 helps to restore self-respect," The Australian, December 30, 1978).

Cricket is a bat and ball game played between two teams of 11 players each on a large grassy field. It is from cricket that the American game of baseball developed. In a cricket match, the teams take turns at bat. While one team bats the other team defends the field. The object of the batting team is to score runs, while the object of the fielding team is to dismiss batsmen. Unlike baseball, there are always two batsmen in play at the same time. Batsmen score runs by exchanging positions on the field.

The center of activity is an area in the middle of the field called the pitch, which corresponds to the infield in baseball. At both ends of the pitch stands a wicket consisting of three vertical sticks, called stumps, with two horizontal sticks, called bails, resting across the top. Wickets are a bit like home plate in baseball. They provide a target for . . .

Cricket is a bat and ball game played between two teams of 11 players each on a large grassy field. It is one of the most popular games in England and several other British Commonwealth countries. In a cricket match, the teams take turns at bat. While one team bats the other team defends the field. The object of the batting team is to score runs, while the object of the fielding team is to dismiss batsmen. In cricket there are always two batsmen in play at the same time. Batsmen score runs by exchanging positions on the field.

The center of activity is an area in the middle of the field called the pitch, which measures 10 feet wide by 66 feet long. At both ends of the pitch stands a wicket consisting of three vertical sticks, called stumps, with two horizontal sticks, called bails, resting across the top. Wickets are 28 inches high and nine inches wide. They provide a target for . . .

A hair raising century by Australian opener Graeme Wood on Friday set England back on its heels in the third test at the Melbourne Cricket Ground. Unfortunately, living dangerously eventually cost the Australians the match. Wood was caught out of his crease on the first over after lunch. Within ten more overs, the Australians were dismissed. Four were dismissed by dangerous running between creases. Two were dismissed when the English bowlers lifted the bails from the batsmen's wickets. The three remaining batsmen were caught by English fieldsmen. One was caught as he tried for a six. When the innings were complete the Australians had fallen short of the runs scored by the English.

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